

**Consultation Response Form** 

Consultation closing date: 20 August 2013 Your comments must reach us by that date

# Reformed GCSE subject content consultation

### The Responses and Comments of The Mathematical Association



If you would prefer to respond online to this consultation please use the following link: <u>https://www.education.gov.uk/consultations</u>

#### Publication

Information you provide in your response to this consultation may be subject to publication or disclosure in accordance with the Freedom of Information Act 2000.

#### Confidentiality

Please make it clear if you want all/any part of your response to be treated as confidential and explain why. If a request for disclosure of the information you have provided is received by DfE, your explanation will be taken into account, but no assurance can be given that confidentiality can be maintained. An automatic confidentiality disclaimer generated by your IT system will not, of itself, be regarded as binding on the Department.

Please tick if you want us to keep your response confidential.	
Reason for confidentiality:	

#### Personal data

For the purposes of the Data Protection Act, DfE is the data controller for any personal data you supply in response to this consultation. DfE will process all personal data (such as your name, address and any other identifying information) in accordance with the Data Protection Act 1998. In most circumstances, this means that your personal data will not be disclosed to third parties.

Please do <u>not:</u>

- ? provide information in comments boxes that might identify you unless you are content for that information to be released into the public domain; or
- ? provide information in your response that might lead to the identification of other living individuals

Name: Dr Chris Pritchard	
Please tick if you are responding on behalf of your organisation.	Ŕ
Name of Organisation (if applicable): The Mathematical Association	
Address: 259 London Road, Leicester LE2 3BE.	

#### Information sharing

The Office of Qualifications and Examinations Regulation (Ofqual) is undertaking a parallel consultation on regulatory conditions for GCSEs. Please tell us if you or your organisation has responded or is intending to respond, to Ofqual's consultation:

Yes	Æ	No	Don't know

Please only respond to the next statement if you have ticked 'no' or 'don't know' above:

If you provide comments to us that are relevant to Ofqual's consultation, we intend to forward your responses to them so they can be considered by Ofqual. If you do <u>not</u> want us to do this then please opt-out by ticking the box below:

I do not want DfE to forward my response to this consultation to Ofqual

Please mark the box that best describes you as a respondent.

	Academy and/or Free School	Comprehensive School	State Selective School
	Independent School	Special School	Sixth Form Only
æ	Subject Association	Organisations representing teachers	Parent
	Young Person	Higher Education	Further Education

Local Authority		Teacher		Governor
Employer/Business	I	Awarding	<u> </u>	
sector		Organisation		

Please Specify:

The Mathematical Association is the country's oldest subject association. It supports good mathematics learning and teaching through interaction with decision makers, by organising conferences and by publishing books and journals. The responses provided here have been put together by the Association's Teaching Committee on behalf of its Council.

#### **OPENING STATEMENT**

The Mathematical Association strongly supports the aspirations that motivated this revision though the published proposals lack clarity and cohesion, and are open to a vast range of interpretations. The dangers we face are that unless the criteria are made more specific, awarding bodies would be at liberty to produce papers which assess the whole range superficially, including the content in bold. This would lead to partial understanding of key concepts whilst undermining the inclination of students to continue studying mathematics and ultimately the country's ability to perform across the STEM domain in business, industry and research.

We recognise that it is not enough merely to criticise the offered criteria without suggesting improvements. And whilst we have done this only in a limited sense ourselves, we are aware of alternative proposals which have attracted serious and substantial contributions from a number of people across the community.

The consultation questions, as they stand, combined with the nature of the criteria offered, are rather superficial. Nevertheless, we have attempted to put our position forward regarding a number of the most relevant questions.

Questions 1-6 below ask you to give your views with reference to a specific subject suite:

- 1. English,
- 2. Mathematics
- 3. Sciences
- 4. Geography
- 5. History
- 6. Modern and ancient languages.

You do not need to give answers for all the subject suites - please answer only with respect to those subjects on which you have a particular view.

*Please ensure that you answer questions 7-11 as well – we would like responses from everyone on those.* 

#### 1. English, including English language and English literature

1a Do **the proposed subject content and assessment objectives** for English, which includes English language and English literature, cover the appropriate knowledge and understanding for GCSEs in these subjects?

Yes	No -insufficiently demanding	No- overly demanding
Not Sure		

Comments:			

1b Is **the relative weighting of the assessment objectives** right for English, which includes English literature and English language?

Yes	No	Not Sure
Comments:		

1c Has the **right practical content** for English language been identified to allow students to gain the skills to progress in the subject, beyond the content which can be examined externally and reliably included in the GCSE grade?

Yes	No	Not Sure
Comments:		

1d Do the proposed subject content and assessment objectives for English, which includes English literature and English language, **provide assurance that essential knowledge taught at the earlier key stages is built upon and represented adequately**?

Yes	No	Not Sure
Comments:		

1e Will the proposed qualifications in English, which includes English language and English literature, secure sound progression for the purposes of further academic and vocational study?

Yes	No	Not Sure
Comments:		

#### 2. Mathematics

2a Do **the proposed subject content and assessment objectives** for mathematics cover the appropriate knowledge and understanding for GCSEs in this subject?

Yes	No -insufficiently demanding	×	No- overly demanding
Not Sure			

#### Comments:

We are pleased that Ofqual and the DfE have confirmed that there is a requirement that all Awarding Bodies assess each bullet point of the Assessment Objectives (AO) on every examination so the marks should be broadly spread across the bullets. This should be rigorously monitored by experts so that interpretation remains valid.

As to the content, it appears to be too ambitious and in parts, overly demanding. There is a welcome greater emphasis on proof and plenty of scope for maintaining and raising the intrigue and interest of high-attaining students. As a result, it would suit the best amongst those going on to A Levels in Mathematics. In fact, the non-bold content, if taught in depth and with rigour, would deliver this.

There are two downsides. Firstly, such content would inevitably lead to shallow and stylised treatment for many, with a focus on the skills required to merely scrape through the examinations. This would impact on the stratum below the highest attainers. It would be better that less is done but to greater depth, so that the necessary fluency in arithmetic and especially in algebra is already in place when it is time to tackle more advanced Mathematics. The aspirations which the content embodies seem at odds with reality. There are few who will rise to meet them, though those who do so would be well served.

Secondly, is the content at all suitable for those students with low prior attainment, who will likely struggle and have their attention divided over too many topics too quickly? Many such students cannot reason adequately even when it comes to money. For many young people, this group included, the most appropriate experience at KS4 gives attention primarily to deepening and extending their grasp of the KS3 curriculum so that they become confident and fluent with a limited range of mathematics, and this should be valued in KS4 assessments.

As intimated in our opening statement, we believe the proposals to be poorly drafted, almost certainly for want of time on the part of those entrusted to undertake the work. Where fundamental changes to curricula and assessment are rushed, the likelihood of unsatisfactory outcomes is increased, and this appears to be the case here. Certainly, the proposals are beset with mathematical errors and inattention to detail. In an attempt to support the redrafting process, we offer in an addendum a commentary on some of the statements in the Scope of Study.

#### 2b Is the relative weighting of the assessment objectives right for mathematics?

Comments:

Overall, we believe that a fair balance (expressed in percentage terms) among fluency, reasoning and problem-solving has been reached. However, the weighting for AO2 is on the ambitious side and, given this novelty, needs careful monitoring for interpretation if implemented as it is.

All young people need to be able to deal with mathematical problems in familiar contexts but we welcome the greater emphasis in the proposals on applying mathematical techniques to unfamiliar problems, as we consider this to be essential in assessing understanding in mathematics. Pupils need to be able to tackle unfamiliar mathematical situations both within and beyond mathematics. Where the wording is not too sophisticated or involved, the current functional mathematics questions support those who are stopping formal mathematics education at GCSE; they help them in life and work. But there is also a place for problems that help students to think deeply about the nature of mathematics, and identify and model relationships by specialising, generalising and abstracting.

These positive comments notwithstanding, we do have some concern that the demands on average-ability candidates might prove unhelpfully challenging. There may be a tension between our ideals and the realities and practicalities. Average-ability candidates will face assessments in which the proportion of marks allocated to straightforward, predictable questions will be fairly low, undermining confidence, whilst a far greater proportion will be allocated to contextualised, functional or multistep questions requiring modelling or sophisticated reasoning. So, the upper end of the range of marks suggested for AO1 (45%, with 18% embedded in AO2/3) might provide for accessible examinations whilst the lower end (35%, with 14% embedded) might not.

The high weight given to communications is to be welcomed. There are ways to communicate complex abstract ideas that too few able students are capable of mastering currently. The rigorous use of symbols and the orderly presentation of an argument should be awarded significant credit.

We are not convinced that having to learn all of the formulae is necessary for the understanding of the subject content.

2c Has the right content for mathematics been identified for high achievers, **including those going on to study A levels** in science, technology, engineering and/or mathematics (STEM)?

Yes	ي No	Not Sure
Commonto:		
Comments:		
The call for th some quarters the non-bold c and techniques	e content in bold to be a p but there would be greater r ontent, so that suitable found s.	prerequisite for Advanced Level is strong i merit in seeking a depth of understanding o idations are in place for advanced concept

2d Do the proposed subject content and assessment objectives for mathematics provide **assurance that essential knowledge taught at the earlier key stages is built upon and represented adequately**?

Yes	No	∠ Not Sure

Comments:

The nature of Mathematics is such that learners are always building on previous levels of understanding and developing more sophisticated skills whilst incorporating what has been learnt previously. So the declaration that KS3 content should be assessed as part of KS4 assessment is welcome. That said, we are concerned not only that the consultation on the curriculum for Key Stage 4 will take place in the coming year once the assessment has been decided, which will leave very little room for manoeuvre, but also that Ofqual's Comparable Outcomes policy appears to have predetermined what the results are to be for the new GCSEs. In short, we seem to have the unhappy sequence: results first, examinations second, learning third and this is far from ideal when designing a robust and coherent 5-16 curriculum.

### 2e Will the proposed qualifications in mathematics secure **sound progression for the purposes of further academic and vocational study**?

Yes	No	🗷 Not Sure

#### Comments:

These qualifications would go some way towards securing sound progression for later academic study in mathematics, should they be accompanied by rigorously monitored and valid assessment. This is also true of high-level vocational studies — some of the new Apprenticeships, for example — where there is a need for complex mathematics and significant levels of abstraction. There are other types of vocational study for which this level of abstraction exceeds what is desirable and manageable.

Overall, we would argue that in order to be able to build for progression we need secure foundations. So rather less should be done but it should be done in greater depth and this will require careful development work on any assessments. In particular, it is better that students have fluency and understanding with the algebra they have, rather than a smattering of more advanced material.

#### 3. Science, including biology, chemistry, physics and combined science

3a Do **the proposed subject content and assessment objectives** for science, which includes biology, chemistry, physics and combined science, cover the appropriate knowledge and understanding for GCSEs in these subjects?

Yes	No -insufficiently demanding	No- overly demanding
Not Sure		

Comments:		

3b Is **the relative weighting of the assessment objectives** right for sciences, which includes biology, chemistry, physics and combined science?

Yes	No	Not Sure
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Comments:	

3c Has the right **practical content** for science been identified to allow students to gain the skills to progress in the subject?

Yes	No	Not Sure
Comments:		

3d Do the proposed subject content and assessment objectives for sciences, which includes biology, chemistry, physics and combined science, provide **assurance that essential knowledge taught at the earlier key stages is built upon and represented adequately**?

Yes	No	Not Sure
Comments:		

3e Will the proposed qualifications in sciences, which includes biology, chemistry, physics and combined science, secure **sound progression for the purposes of further academic and vocational study**?

Yes	No	Not Sure
Comments:		

## 3f Will the combined science double award provide students with a sufficiently secure basis for progression to A level study of each of biology, chemistry and physics?

Yes	No	Not Sure
Comments:		

#### 4. Geography

4a Do **the proposed subject content and assessment objectives** for geography cover the appropriate knowledge and understanding for GCSEs in this subject?

Yes	No -insufficiently demanding	No- overly demanding
Not Sure		
Comments:		

4b ls **the relative weighting of the assessment objectives** right for geography?

Yes	No	Not Sure
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Comments:		

4c We are working on options to ensure that fieldwork takes place. One option might be a letter, submitted to AOs and signed by the head teacher and head of geography, which states that fieldwork has taken place beyond the classroom and school grounds. Do you think this would be **an effective measure to demonstrate that fieldwork has taken place beyond the classroom and school grounds?** 

Yes	1	No		Not Sure
Do you have a the classroom	Do you have any other suggestions to verify that fieldwork has taken place beyond the classroom and school grounds?			

## 4d Do the proposed subject content and assessment objectives for geography provide assurance that essential knowledge taught at the earlier key stages is built upon and represented adequately?

Yes	No	Not Sure
Comments:		

4e Will the proposed qualifications in geography secure **sound progression for the purposes of further academic and vocational study**?

Yes	No	Not Sure
Comments:		

#### 5. History

5a Do **the proposed subject content and assessment objectives** for history cover the appropriate knowledge and understanding for GCSEs in this subject?

Yes	No -insufficiently demanding	No- overly demanding
Not Sure		

Comments:		

#### 5b Is the **relative weighting of the assessment objectives** right for history?

Yes	No	Not Sure

Comments:		

5c Should students be encouraged, as part of their GCSE history studies, to undertake a historical investigation that gives them the opportunity to conduct independent research into a historical issue, event or process of their choosing resulting in an extended essay?

Yes	No	Not Sure
If so, how can thi	s be achieved best?	

5d Do the proposed subject content and assessment objectives for history provide assurance that essential knowledge taught at the earlier key stages is built upon and represented adequately?

Yes	No	Not Sure
Comments:		

5e Will the proposed qualifications in history secure **sound progression for the purposes of further academic and vocational study**, including encouragement of the ability to conduct independent study in the subject?

Yes	No	Not Sure
Comments:		

#### 6. Modern and ancient languages

6a Do **the proposed subject content and assessment objectives** for modern and ancient languages cover the appropriate knowledge and understanding for GCSEs in these subjects?

Yes	No -insufficiently demanding	No- overly demanding
Not Sure		

Comments:		

6b Is **the relative weighting of the assessment objectives** right for modern and ancient languages?

Yes	Not Sure
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Comments:		

6c Do the proposed subject content and assessment objectives for modern and ancient languages provide assurance that essential knowledge taught at the earlier key stages is built upon and represented adequately?

Yes	No	Not Sure
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Comments:		

6d Will the proposed qualifications in modern and ancient languages secure **sound progression for the purposes of further academic and vocational study**?

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Comments:

Please answer all the remaining questions, which include questions on literacy, numeracy and impact on specific groups of students.

7 Does the English language content cover the **key elements of literacy needed for employment or further study**?

Yes	No	Not Sure
Comments:		

8 Does the mathematics content cover **the key elements of numeracy needed for employment or further study**?

Yes	No	Mot Sure
Comments:		
It rather depe elements of r covered if the throughout, ind teaching to the absorbed suffic	ends on interpretation. It wo numeracy required for emp mathematics in context and p cluding in AOs. We are conc examination, there is every ciently well to be used in diffe	build be easier to judge whether the key loyment or further study are adequately problem solving were highlighted separately cerned that where there is an emphasis on possibility that the key elements will not be rent contexts.

9 Do any of the proposals have potential to have a **disproportionate impact**, **positive or negative**, **on specific pupil groups**, in particular the 'protected characteristic' groups? (The relevant protected characteristics are disability, gender reassignment, pregnancy and maternity, race, religion or belief, sex and sexual orientation); if they have potential for an adverse impact, how can we reduce this?

Yes - Positive impact	Yes - Negative impact	No
Not Sure		
Comments:		

10 Have you any further comments?

Comments:

11 Please let us have your views on responding to this consultation (e.g. the number and type of questions, whether it was easy to find, understand, complete etc.).

Comments:

#### Addendum: Commentary on Some Statements in the Scope of Study (Mathematics)

#### Number

4. How do you rationalise the denominators of multiples of p?

#### Algebra

2. If this means moving from  $x^2$  ? 3 to x ? ? $\sqrt{3}$ , then this is fine but would we really expect all candidates to face questions where they were required to manipulate polynomials with surd coefficients? This is probably not necessary even for the bold. However, the words 'or more' in 'expanding products of two or more binomials' should be in bold, with the same marking for factorising quadratics with a coefficient of  $x^2$  greater than 1.

4. There seems to be a confusion of equation and formula here. In particular, how do you solve a formula?

5. This quite reasonably introduces *function notation* but later on the idea of *function* is needed (amid much confusion over what a function is).

7. All references to finding the inverse of one-to-one functions should be removed from this bullet point and replaced with changing the subject of a formula. If this is not acceptable, then domain must be considered and this should be bold.

9. It is unfortunate that vertical lines are omitted.

10. Should cubics be in bold?

11. We have what are claimed to be functions here where rules are given but not domains. The domains of the exponential and trigonometric functions need to be made clear because they have pedagogical consequences. For example, from page 13 it appears that trig functions have domain at most [0,90] in its first figure, whilst the second figure seems to take us onto [0, 180]. Now whilst there may not have been any intention that the diagrams in the Appendix imply this, a domain such as [-360, 360] could be stated for these trigonometric functions. Further, we note that graphing reciprocal functions is in bold in 25 and non-bold here.

12. It is possible to translate and reflect curves (geometrical objects) and possibly graphs (depending on how you define them) but functions cannot be translated or reflected. This sloppiness of language is the sort of thing that engenders misunderstanding and confusion later on.

#### Algebra

11. and 25. There is an inconsistency to be resolved regarding what is in bold.

14. Geometric progressions for all candidates seems over the top and asking for stereotyped questions.

15. Does *deduce* quadratic expressions imply use of the method of differences? And would that use carry with it any understanding?

16. What does *deduce* mean here?

17. It seems odd that arithmetic sequences are omitted when quadratic and geometric are present, especially with the inclusion of the long term behaviour of the former.

18 and 20. Are only those equations to be solved which the candidate has constructed?

21. The requirement to deduce algebraically the roots of a quadratic (without restriction) seems unreasonable for all candidates given the only technique they have is factorising (from 20). Perhaps all the algebra in point 21 should be restricted to higher attaining candidates?

22. This is suitable for all candidates and does not therefore need to be in bold.

- 23. 'or' should be in bold.
- 24. Replace set notation with using inequalities.
- 25. 'speed' would probably be better in the context alluded to, i.e. speed-time graphs.
- 26. 'graphs in financial contexts' seems dangerously vague.

#### Ratio, proportion and rates of change

3.?

4.? 'inverse proportion' should be bold content.

9.?

#### Geometry and measures

2. Is it reasonable to expect all candidates (or even the bold) to *derive* formulae for the surface areas and volumes of spheres, pyramids and cones, or even for the perimeter and area of a circle?

#### Geometry and measures

6. This is a very broad statement which is open to a range of unstated possibilities. It might be replaced with references to plans and elevations and isometric drawing, bringing specificity and context.

10. The latter part of this point should be in bold.

16. The less able are unlikely to understand trigonometry; we suggest removal of this content for them.

17. The reference to 3D Pythagoras should be removed and replaced with Pythagoras' Theorem that may require more than one application. If this is not possible, then this bullet point should be reworded to make it clear whether trigonometry in 3D should be taught or just Pythagoras. (The spelling / use of the apostrophe in Pythagoras's theorem is wrong. When the allusion is to a figure from ancient times, there should be a single apostrophe at the end of the name, thus Pythagoras' Theorem or Pythagoras' theorem.)

19. A translation is a transformation; it is not a vector, although a vector might be given as part of its description. This seems to be a confusion of an object with its measure.

#### Probability

7. It is unfortunate that tree diagrams have been privileged here, especially when a range of alternatives is given in 8.

8. Demanding use of the conditional probability formula seems a step too far. It is imposing a formalism which is often poorly understood, when understanding is vital here: if one is sitting on a jury a formal argument is not needed but one does need to be able to spot inappropriate conditionality or claims of independence in arguments. If the topic has

to be included, then perhaps one way forward would be to make use of two-way tables and Venn diagrams, avoiding tree diagrams and the use of the formula.

#### Statistics

Firstly, the removal of the Data Handling Cycle and its inclusion in the content for Science (compulsory at KS4) and Geography (optional at KS4) has clear consequences for the way in which departments interact. It may be necessary for a member of each Mathematics Department to be charged with ensuring through suitable liaison that such elementary statistical elements are included across the curriculum. This would still require that the WHY? of statistics be handled by mathematicians.

3. Histograms with equal class intervals does not need to be bold.

4. It would be better for cumulative frequency to be in bold (as indeed it is in bullet point 3) and similarly for quartiles and inter-quartile range.

5. Calculation of lines of best fit is likely to lead to rote calculations (or just reading values off calculators) with no understanding. One way to handle this is to position the line by eye, perhaps not even demanding that the line passes through  $2\overline{x}, \overline{y}^2$ , constructing a right-angled triangle beneath and finding the gradient therefrom. Then use substitution to find the intercept, not allowing it to be read from the graph. The use of broken axes would ensure this.

It seems very odd that regression is being considered without correlation. Scatter plots are to be considered but only in the context of putting lines on them, without any discussion of whether it makes sense to draw the lines. It seems that this bullet point is based round an imperative to calculate with rather than to interpret bivariate observations which would be much healthier.

The dangers of extrapolation should be highlighted; statisticians treat it with extreme caution because of the increasing likelihood of making incorrect judgements as the distance from the data set increases.

#### Appendix 1

Page 12 – The four formulae relating to cones and spheres on this page do not currently have to be memorised by candidates (higher): would it be better if they were still provided to candidates, but that 'good' questions were asked involving their use? If they are provided for all candidates they do not need to be in bold but if they have to be memorised they must be in bold.

#### Page 13 – Trigonometry formulae

There is inconsistent use of italics; also, there is an unfortunate inconsistency between Pythagoras' theorem where  $c^2$  is the subject and the cosine rule where  $a^2$  is the subject. The last three formulae in the trigonometry section do not currently have to be memorised by candidates (higher): is there really a need for this to change? Also, they need to be bold if they are to be memorised.

#### Page 13 – Kinematics formulae

How much error can you build into a simple formula? Both formulae seem to be attempting average quantities and should say so. The first formula equates a vector to a scalar. (At this level it may be better to talk about average speed rather than velocity.)

Page 14 - (a) (v) This should be the 'quadratic formula'. As it is not for all candidates, it should be in bold.

Page 14 – (b) (i)

There is inconsistent use of italics. The use of the word 'speed' would be preferable.

Page 14 – (b) (ii)

An alternative to 'accrued' should be sought. The formula itself should be removed as it not needed *per se*.

Page 14 (iii)

These formulae should be removed from the sheet altogether. This would be consistent with our position on Probability (bullet number 8).

Thank you for taking the time to let us have your views. We do not intend to acknowledge individual responses unless you place an 'X' in the box below.

Please acknowledge this reply.	Ŕ
E-mail address for acknowledgement: chrispritchard2@aol.com	

Here at the Department for Education we carry out our research on many different topics and consultations. As your views are valuable to us, please confirm below if you would be willing to be contacted again from time to time either for research or to send through consultation documents.

Ľ	Yes		No
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All DfE public consultations are required to meet the Cabinet Office <u>Principles on</u> <u>Consultation</u>

The key Consultation Principles are:

- ? departments will follow a range of timescales rather than defaulting to a 12-week period, particularly where extensive engagement has occurred before
- ? departments will need to give more thought to how they engage with and consult with those who are affected
- ? consultation should be 'digital by default', but other forms should be used where these are needed to reach the groups affected by a policy; and
- ? the principles of the Compact between government and the voluntary and community sector will continue to be respected.

Responses should be completed on-line or emailed to the relevant consultation email box. However, if you have any comments on how DfE consultations are conducted, please contact Carole Edge, DfE Consultation Coordinator, tel: 0370 000 2288 / email: carole.edge@education.gsi.gov.uk

#### Thank you for taking time to respond to this consultation.

Completed responses should be sent to the address shown below by 20 August 2013

Send by post to: Qualification and Assessment Division Department for Education L2 Sanctuary Buildings Great Smith Street London SW1P 3BT

Send by e-mail to: GCSEcontent.consultation@education.gsi.gov.uk